has been formed is subjected to a discharging surface treatment are altered according to the characteristics of the treatment target material.

Page 6, paragraph 2, replace with the following new paragraph

In the discharging surface treatment method according to a second aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode, and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment are altered at least once according to the characteristics of the treatment target material.

Page 7, paragraph 1, replace with the following new paragraph

In the discharging surface treatment method according to a third aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode, and the

a_3 cont'd electrical conditions at the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment are altered according to the characteristics of the treatment target material, while the electrical conditions at the time when the hard coat film that has been formed is subjected to a discharging surface treatment are altered at least once according to the characteristics of the treatment target material.

Page 8, paragraph 1, replace with the following new paragraph

a_4 In the discharging surface treatment method according to a fourth aspect of this invention, in the configuration according to the first aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

Page 8, paragraph 2, replace with the following new paragraph

a_5 In the discharging surface treatment method according to a fifth aspect of this invention, in the configuration according to the second aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

Page 8, paragraph 3, replace with the following new paragraph

a_6 In the discharging surface treatment method according to a sixth aspect of this invention, in the configuration according to the third aspect of this invention, it is preferable that an inert gas is interpolated between the discharge processing electrode and the treatment target.

Page 8, paragraph 4, replace with the following new paragraph

a_7 In the discharging surface treatment method according to a seventh aspect of this invention, in the configuration according to the first aspect of this invention, it is preferable that

a7 cont'd the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

Page 8, paragraph 5, replace with the following new paragraph

a8 In the discharging surface treatment method according to a eighth aspect of this invention, in the configuration according to the second aspect of this invention, it is preferable that the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

Page 9, paragraph 1, replace with the following new paragraph

a9 In the discharging surface treatment method according to a ninth aspect of this invention, in the configuration according to the third aspect of this invention, it is preferable that the discharge processing electrode is allowed to scan the treatment target so that the hard coat film is formed on the surface of the treatment target.

Page 9, paragraph 2, replace with the following new paragraph

a10 In the discharging surface treatment device according to a tenth aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the above-mentioned device is provided with a switching unit which alters the electrical conditions at the

time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment according to the characteristics of the treatment target material.

Page 10, paragraph 1, replace with the following new paragraph

In the discharging surface treatment device according to an eleventh aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the device is provided with a switching unit which alters the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment at least once according to the characteristics of the treatment target material.

Page 10, paragraph 2, replace with the following new paragraph

In the discharging surface treatment device according to a twelfth aspect of this invention, a powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table is mixed ferrous-family metal powder or non-ferrous metal powder having the same composition as the treatment target as a simple substance or a combination of a plurality of metals, and this is

compressed and molded, and then burned at a temperature at which the ferrous-family or non-ferrous metal powder starts to elute to form an electrode serving as a discharge processing electrode. Moreover, the above-mentioned device is provided with a first switching unit which alters the electrical conditions at the time when the base member of the treatment target is directly subjected to a discharging surface treatment and the electrical conditions at the time when a hard coat film that has been formed is subjected to a discharging surface treatment according to the characteristics of the treatment target material, and a second switching unit which alters the electrical conditions at the time when the hard coat film that has been formed is subjected to a discharging surface treatment at least once according to the characteristics of the treatment target material.

Page 11, paragraph 1, replace with the following new paragraph

In the discharging surface treatment device according to a thirteenth aspect of this invention, in the configuration according to the tenth aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge processing electrode and the treatment target.

Page 11, paragraph 2, replace with the following new paragraph

In the discharging surface treatment device according to a fourteenth aspect of this invention, in the configuration according to the eleventh aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge processing electrode and the treatment target.

Page 12, paragraph 1, replace with the following new paragraph

A15

In the discharging surface treatment device according to a fifteenth aspect of this invention, in the configuration according to the twelfth aspect of this invention, it is preferable that an inert-gas supplying unit is installed so as to interpolate an inert gas between the discharge processing electrode and the treatment target.

Page 12, paragraph 2, replace with the following new paragraph

A16

In the discharging surface treatment device according to a sixteenth aspect of this invention, in the configuration according to the tenth aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the sintered electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

Page 12, paragraph 3, replace with the following new paragraph

A17

In the discharging surface treatment device according to a seventeenth aspect of this invention, in the configuration according to the eleventh aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the discharge processing electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the sintered electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

Page 13, paragraph 1, replace with the following new paragraph

a_{18} In the discharging surface treatment device according to a eighteenth aspect of this invention, in the configuration according to the twelfth aspect of this invention, it is preferable that an X-axis driving device, a Y-axis driving device and a Z-axis driving device, which relatively shift the discharge processing electrode and the treatment target in the X-direction, Y-direction and Z-direction, are installed so that the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the sintered electrode to scan the treatment target to form the hard coat film on the surface of the treatment target.

Page 14, paragraph 4, replace with the following new paragraph

a_{19} In addition to the effects of the first aspect, the discharging surface treatment method according to the seventh aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size sintered electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 14, paragraph 5, replace with the following new paragraph

a 20

In addition to the effects of the second aspect, the discharging surface treatment method according to the eighth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 15, paragraph 1, replace with the following new paragraph

a 21

In addition to the effects of the third aspect, the discharging surface treatment method according to the ninth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 16, paragraph 4, replace with the following new paragraph

a 22

In addition to the effects of the tenth aspect, the discharging surface treatment device according to the sixteenth aspect makes it possible to use a small-size discharge processing

A22 cont'd

electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 17, paragraph 1, replace with the following new paragraph

A23

In addition to the effects of the eleventh aspect, the discharging surface treatment method according to the seventeenth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 17, paragraph 2, replace with the following new paragraph

A24

In addition to the effects of the twelfth aspect, the discharging surface treatment method according to the eighteenth aspect makes it possible to use a small-size discharge processing electrode, and the process is carried out with this electrode being allowed to scan. Therefore, it is not necessary to use a large-size discharge processing electrode having a specific shape, and it is possible to form a hard coat film with the small-size discharge processing electrode being

allowed to scan on the entire curved face of the treatment target, such as a mold, having a three-dimensional free curved face, so as to have a uniform thickness over the entire area or a varied film thickness, if necessary.

Page 18, paragraph 1, replace with the following new paragraph

Fig. 1 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a first embodiment of the present invention. Reference number 2 represents a treatment target, and reference number 3 represents a processing vessel. Reference number 4 represents a processing fluid, such as insulating oil or water. Reference number 10 represents a shifting motor, and reference number 11 represents a shifting thread. Reference number 12 represents a discharge processing electrode, and reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. The shifting motor 10, controlled by a controlling system not shown, is designed so that the discharge processing electrode 12 is shifted toward the treatment target 2 in a desired control mode, such as a servo-shifting mode and a constant-shifting mode, through the shifting thread 11.

Page 20, paragraph 2, replace with the following new paragraph

A method of manufacturing the discharge processing electrode 12 will now be explained. A powder that is formed by a simple substance or a combination of a plurality of carbides of metals belonging to the IVa, Va and VIa families in the Periodic Table (for example, WC, TiC, TaC, etc.) is mixed ferrous-family metal powder such as Fe, Co and Ni, or non-ferrous metal powder having the same composition as the treatment target (for example, Al alloy powder, etc.)

as a simple substance or in combination, and this is compressed and molded into a predetermined shape, thereby manufacturing a green compact electrode. Then, this is put into a vacuum furnace, etc., and the temperature inside the furnace is gradually increased so as to harden the green compact electrode to a degree, for example, approximately as hard as chalk so that it has sufficient strength to withstand a mechanical machining process and also is not hardened too much (this process is referred to as "preliminary sintering process"). In this state, the ferrous-family metal such as Co starts to elute to be buried in gaps between carbides, thereby forming a so-called solid solution. In contrast, at contact portions between the carbides, although mutual bonding progresses, the bonding is weak because the burning temperature is comparatively low with the result that a main sintering process is not attained. The discharge processing electrode in this state, which has been subjected to the preliminary sintering process, is taken out, and machined and sized to a predetermined shape. Thus, this is used as the discharge processing electrode 12.

Page 21, paragraph 1, replace with the following new paragraph

The conditions of the above-mentioned preliminary sintering process are different depending on electrode materials. However, this is determined preliminarily through experiments. For example, the burning temperature is set approximately in the range of 400 to 1100 degree centigrade.

Page 22, paragraph 1, replace with the following new paragraph

In this case, it is essential not to raise the burning temperature in a preliminary sintering process to approximately not less than 1100 degree centigrade. The temperatures exceeding this

temperature make the electrode too hard, resulting in a problem in which in the next discharging process, the electrode material comes off irregularly due to a thermal impact caused by arc discharging, failing to properly supply discharging between the electrodes, resulting in serious adverse effects to the quality of the coat film formed on the treatment target.

Page 22, paragraph 2, replace with the following new paragraph

Next, an explanation will be given of a formation method of the hard coat film 13. When an arc discharge is generated intermittently or continuously between the discharge processing electrode 12 and the treatment target 2, the pole-to-pole gap has a high temperature locally due to arc heat First, when an arc discharge is generated once, one portion of the electrode material comes off between the poles, and is simultaneously discharged in a powdered state by the thermal impact energy at portions of the discharge processing electrode 12 preliminarily sintered facing the treatment target 2. Since the pole-to-pole gap enters a high-temperature plasma state of not less than several thousands of degree centigrade momentarily, most portions of the electrode material are completely fused. The surface of the treatment target facing the electrode is also heated instantaneously at the generation position of the arc discharge, and fused in the same manner as the electrode material. At this high-temperature state, the fused electrode material and the treatment target are mutually mixed with each other to form an alloy phase between the electrode material and the treatment target on the treatment target. Next, since the processing fluid is located in the pole-to-pole gap and in the vicinity thereof, this is abruptly cooled off, and during a cooling phase from the high-temperature state, an interface reaction between the liquid phase of the ferrous-family metal and the solid phase of the carbides or a

solid-solution forming reaction between the solid phases of the carbides instantaneously occurs, thereby executing a main sintering process in an extremely short time. In this manner, a hard coat film 13 is formed on the treatment target 2. When this process is repeated, the deposition of the coat film progresses as the time elapses, thereby making it possible to form a thick film.

Page 23, paragraph 2, replace with the following new paragraph

Fig. 3 shows a state in which a thick film is formed and a discharge current at this time. WC-Co is used as the discharge processing electrode 12 and a steel plate is used as the treatment target 2. Moreover, Fig. 3(a) shows a case in which a discharge is directly applied to the base member of the treatment target 2, and Fig. 3(b) shows a case in which, after a hard coat film 13 has been formed, a discharge is further applied thereto. Depending on the cases in which a discharge is directly applied to the base member of the treatment target 2 and in which a discharge is applied after the hard coat film 13 has been formed, electrical conditions including the discharge current value Ip, the discharge current pulse width τp and the pause time τr are properly altered so as to fit to the characteristics of the subject material. Moreover, depending on cases, the poles of the electrode are also changed. This is because the base member and the hard coat film formed later are respectively different in material characteristics and hardness. Therefore, the electrical conditions are altered so as to fit to the characteristics of the subject material depending on the cases in which a discharge is directly applied to the base member and in which a discharge is further applied after the hard coat film has been formed so as to fit to the characteristics of the subject material; consequently, the electrical conditions suitable for the corresponding subject material are adopted so that it becomes possible to carry out the process in

A30 a shorter time, and also to form a hard coat film with high adhesion. Such electrical conditions suitable for the respective characteristics of the subject materials are preliminarily determined through experiments, etc., and the control device 14 alters these according to the characteristics of the subject material. For example, the alteration of each of the discharging current value Ip, the discharging current pulse width τp and the pause time τr is carried out by switching operations of switches 15 and 16 and the controlling operations of the switching in the control circuit shown in Fig. 4.

Page 26, paragraph 1, replace with the following new paragraph

A31 Fig. 5 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a second embodiment of the present invention. Reference number 2 represents a treatment target, and reference number 12 represents a discharge processing electrode. Reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. The hard coat film 13 is formed on the surface of the treatment target 2 while the discharge processing electrode 12 and the treatment target 2 are relatively shifted in the X-direction, Y-direction and Z-direction by using an X-axis driving device, a Y-axis driving device and a Z-axis driving device, not shown. For example, when the treatment target 2 is a mold, its surface is not a plane face, and has a three-dimensional shape with complex free curved faces. However, the X-axis driving device, the Y-axis driving device and the Z-axis driving device allow the discharge processing electrode 12 to scan along the free curved face of the mold with the gap being maintained constant or the servo-voltage being

a 31 cont'd

maintained constant. In this case, since the electrode is consumed very quickly, a compensating shifting operation is required for compensating for the electrode consumption. Therefore, the movement control of the main axis for supporting the electrode in the Z-axis direction needs to be carried out accurately and quickly. The above-mentioned operations are repeated so that the electrode is allowed to scan all over the curved faces constituting the mold. Thus, it becomes possible to deposit the hard coat film over the entire area uniformly, or with a varied film thickness, if necessary.

Page 27, paragraph 2, replace with the following new paragraph

a 32

Fig. 6 is a structural drawing that shows a discharging surface treatment method and a device for such a method according to a third embodiment of the present invention. This embodiment explains a discharging operation performed in the environment of gas. Reference number 2 represents a treatment target. Reference number 10 represents a shifting motor, and reference number 11 represents is a shifting thread. Reference number 12 represents a discharge processing electrode, and reference number 13 represents a hard coat film formed on the treatment target 2. Reference number 14 represents a control device, provided with a power supply, for controlling a current and a voltage. Reference number 17 represents a gas supply source, and reference number 18 represents a path and 19 is a supply pipe. The gas supply source 17 is connected to the path 18 installed inside the discharge processing electrode 12 through a pipe. While power is supplied by the power supply of the control device 14, inert gas, such as air or nitrogen gas, is supplied at a predetermined amount from the gas supply source 17. The supply pipe 19 is used for supplying gas from the outside of the electrode when a path is not

formed inside the electrode, and in this case, gas is discharged toward the pole-to-pole gap. The objects of the gas supply are to cool off the pole-to-pole gap and to transport excessive electrode materials out of the system, and these object are the same as those of the processing fluid. Without the gas supply, it is difficult to form the hard coat film on the treatment target in a stable manner. With respect to the kinds of gases, air or nitrogen gas is suitable from the environmental point of view.